Spatio-temporal Trends of Female Discrimination in Tamil Nadu, South India: A Case Study of Salem and Dharmapuri Districts, 1961-1991

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SPATIO-TEMPORAL TRENDS OF FEMALE DISCRIMINATION IN TAMIL NADU, SOUTH INDIA: A CASE STUDY OF SALEM AND DHARMAPURI DISTRICTS, 1961-1991

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Introduction

The sex ratio[1] (SR) is employed as a good expression of the status of women in a society. It is the result of sex ratio at birth (SRB) and of differential mortality according to sex and migrations. Yet, the juvenile sex ratio (JSR, for 0-6 years population) is generally not influenced by migration, which is very moderate in these age groups; it is consequently a valuable indicator of the situation of girls. We shall therefore use the SRB as well as the JSR and the SR in the characterization of sex discrimination.

The sex ratio of the Indian population, as well as the JSR, has been diminishing almost regularly since 1901, particularly in some regions of the country, because of specific discriminatory socio-cultural practices rooted in the context of the Indian patriarchy. To the infanticide of newborn girls was added, some thirty years ago, the sex selective abortion of female embryos. Since the time India adopted new technologies to determine the sex of the foetus, nothing has really been done to arrest their progression, except the law of 1994 and its amendments.

These techniques are amniocentesis and the sexing of embryos according to the method of Ericsson, by separation of the spermatozoids x and y and artificial insemination (RCWS, 1994: 11-15). Moreover, a most recent pre-implantation genetic diagnosis technology, a preconception

[1] Calculated here as the number of women per 1000 men.

method, is used, whereas ultrasound scanning remains the most affordable for most of the population (Mazumdar 1994). Another discriminatory behaviour is the negligence towards girls, which can be broken down in terms of care and alimentation. Of course, we do not develop here all the other determinants of the sex-ratio such as maternal mortality, the maltreatment of women, burning of wives, the malnutrition of women and so on, which also contribute to low sex ratios.

To measure this sex discrimination, we conduct a cartographic study at two levels in Tamil Nadu, in order to map the abnormalities of the juvenile sex ratio and the sex ratio, which denote significant behaviour variations. This research aims at providing some responses to the fact that gender discrimination exists in certain regions of Tamil Nadu. We first describe the trends in sex ratio differentials in South India. Then, we look more closely at the variations and micro-spatio-temporal trends in Tamil Nadu[2]. We then investigate the sex ratios in the districts of Salem and Dharmapuri from 1961 to 1991 (Figure 1: map of India). In conclusion, we provide some explanations concerning this phenomenon, as statistically and spatially recorded, notably by introducing of the concept of diffusion.

Sex ratio differentials in South India

This research was conducted in South India for different reasons: sex discrimination is less studied there than in the North, where the sex ratio has been widely analysed (Visaria 1999: 81-88, for instance) and is well documented (Das Gupta, Chen and Krishnan 1995). Furthermore, the relative homogeneity among the southern states has given place to the traditional North-South dichotomy, but we wish now to show that, on smaller scales, heterogeneities exist among the four states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh, and that Tamil Nadu presents specificities in the matter of sex discrimination. An additional reason is the availability of the spatialized database from the South India Fertility Project of the French Institute, which allowed us to obtain spatial data on sex ratios.

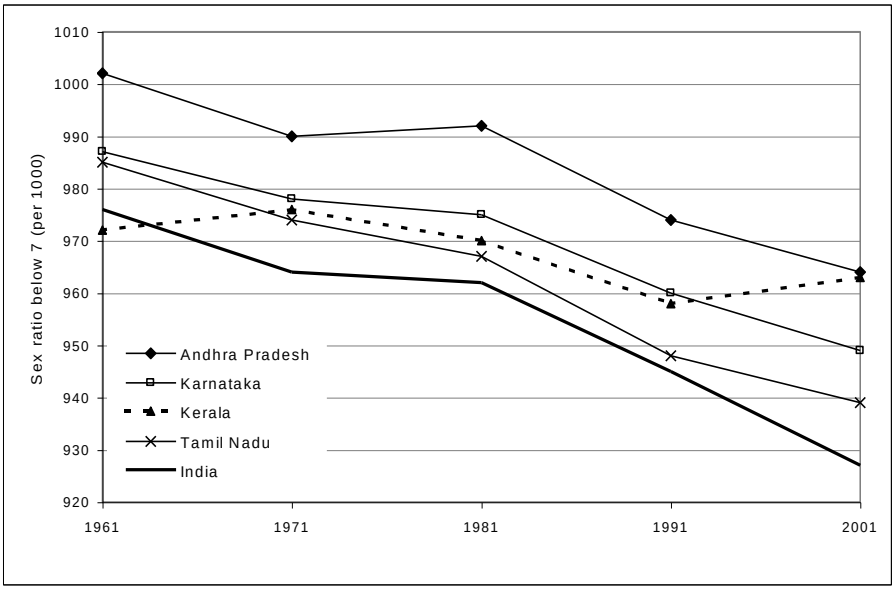
The sex ratio at birth from the 1981 and 1991 censuses, calculated with indirect statistical methods (Sudha and Rajan 1999), reflects the behaviour during pregnancy, and notably concerning sex-selective abortions. In South India, we observe a generalized sinking of the SRB from 1981 to

[2] This part, as the first part, is inspired by an article to be published in 2005 in Sage.

1991 (the SRB for 2001 has not been yet estimated). This decline exists in rural and also in urban areas for the four South Indian states, except for urban Kerala, where the SRB does not decline. As for the sex ratio at birth in Tamil Nadu, it was 931 in 1999, as compared with 952 in 1991. It underwent many fluctuations from one year to the next, but it has a declining tendency (Directorate of Public Health, 1999).

Otherwise, the general trend during the last five decades has been a deterioration in the juvenile sex ratio, overall and nearly regular in South India (Figure 2). Andhra Pradesh and Karnataka, where the JSR is higher, have decreased in parallel, except in 1981 when the JSR in Andhra Pradesh underwent a slight increase. Kerala follows an opposite trend and displays in 2001 the highest level in South India, along with Andhra Pradesh. On the other hand, Tamil Nadu records the most rapid decline, from 985 in 1961 to 939 in 2001, and its JSR is only slightly higher than the national average. Moreover, an interesting characteristic of Tamil Nadu is that, other than its very low total JSR, the JSR is lower in the rural zones. Elsewhere in India,

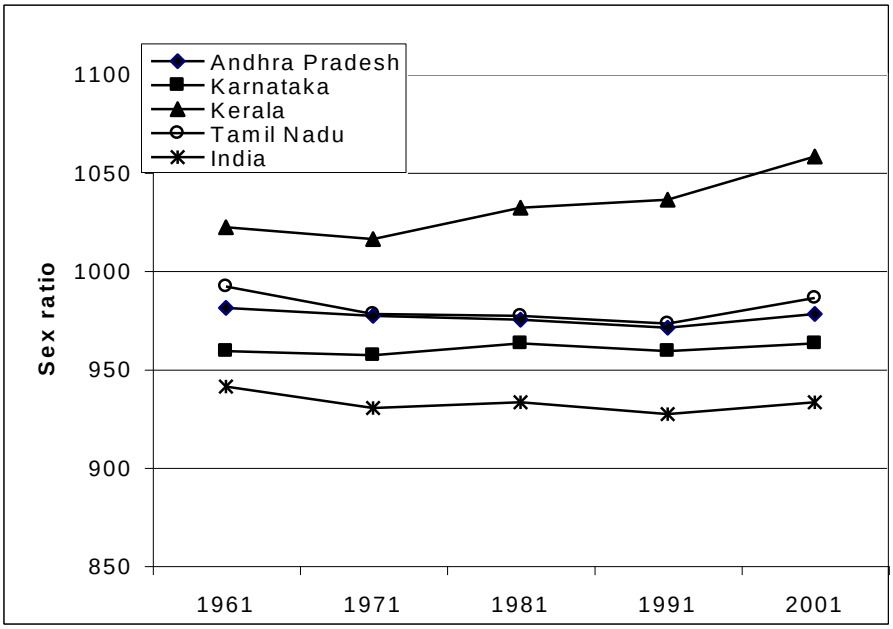
Figure 2: Juvenile sex ratio (girls per 1000 boys below 7) in South India and India, 1961-2001



Source: Census of India, various years, Vella, 2005.

it is rather in the urban zones that girls are less numerous, a phenomenon which can be related to urban attitudes, as well as to the existing medical infrastructure and the availability of sex selective abortion. This would not be true in the case of Tamil Nadu (Vella 2005).

Figure 3: Sex ratio (women per 1000 men) in South India and India, 1961-2001



Source: Census of India, various years.

Concerning the sex ratio, there is no big difference at the state level, but the trend is not so clear as in the case of the juvenile sex ratio. We observe a better result for 2001 than for 1991, especially in the case of Kerala, where the sex ratio is regularly increasing (Figure 3). The role of migrations has to be considered in this state, as well as the better status of women. The social development is actually more advanced in Kerala, which stands out significantly from the trend in South India. In contrast, the three other states are much less "developed" and more agricultural. Andhra Pradesh paradoxically distinguishes itself by an unfavourable level of development but the most balanced juvenile sex ratio. It emerges from this analysis that the statistics for Tamil Nadu are highly unfavourable to girls.

Sex ratio variations in Tamil Nadu

Tamil Nadu has a low fertility that declined rapidly (2.1 in 1991), being the second lowest in India after Kerala (Sudha and Rajan 1999). Among the large states, Tamil Nadu is known as being quite advanced respective of a number of social indicators (literacy of girls, total sex ratio, participation of women in work and infant mortality rate), although behind Kerala (Vella 2005).

TABLE 1: Sex ratio of children below 7 years and sex ratio, 1991 and 2001, selected districts of Tamil Nadu

Districts / year	SR06 1991	SR06 2001	SR 1991	SR 2001
Salem	849	826	925	929
Dharmapuri	905	878	942	938
Theni	*	893	964	979
Vellore	970	937	978	997
Madurai	918	927	964	978
Namakkal	*	895	960	967
Perambalur	*	944	975	1007
Dindigul	934	929	976	986
Nilgiris	968	990	983	1015
Pudukkottai	976	965	1005	1015
Tamil Nadu	948	939	974	986

SR06: Sex ratio below 7 years

*: Districts that did not exist in 1991.

Source: Indian Censuses 1991 and 2001.

In Tamil Nadu in 2001, ten out of thirty districts had juvenile sex ratios below the state average of 986, such as Dharmapuri (918 in 1991 to 878) and Salem (849 to 826) (Table 1). In 2001, the latter has the lowest JSR of all districts in India. The 54 Indian districts that had a JSR below 900 were in the North in 1991, Salem excepted. But in 2001, more districts in Tamil Nadu were under 900, such as Dharmapuri, which appears from that moment as a highly discriminatory place. A decrease is observed in the districts of Tamil Nadu. In 2001, the ratio increased in some districts, for instance Madurai or the Nilgiris (Table 1).

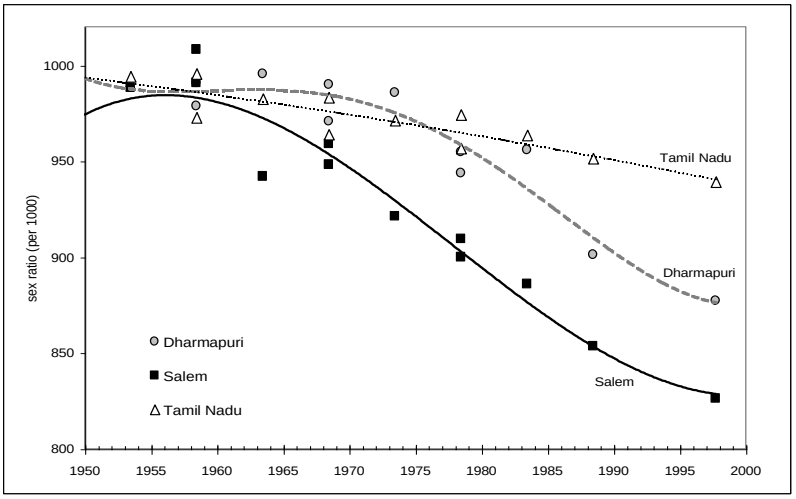
In some parts of northern Tamil Nadu, the sex ratio at birth in 1999 also appears to be lower than the state average of 931, with the exceptionally low figure of 858 in Salem. In the case of the SRB, the figures prove that the districts with a low SRB can be linked to districts for which the figures are abnormal for the other variables and to districts where infanticide is recorded. The sex ratio is increasing in all the selected districts of Tamil Nadu (Table 1) from 1991 to 2001, except in Dharmapuri; this trend confirms that this district reacts later than the other discriminatory places. Concerning the two districts of Salem and Dharmapuri, they have the highest decline of sex ratio for 40 years, from 1961 to 1991. The sex ratio is around 930 – 940, whereas it is between 960 and 1015 in other districts.

Thus, the major cause of this female excess mortality is female infanticide and more recently sex selective abortion. In 1999, this infanticide amounted to 16 per cent of the female infant mortality in Tamil Nadu (DANIDA Tamil Nadu Area Health Care Project – Phase III, 1999). At least 3 500 to 4 000 girls died in this way each year. The imprecision of the figure results mainly from the registration of this type of death by the health personnel (higher risk of under-registration). In 1999, infanticide would have represented 64 per cent of the female infant deaths in Salem, 48 per cent in Dharmapuri and 22 per cent in Madurai (DANIDA Tamil Nadu Area Health Care Project – Phase III, 1999).

The figure below displays data from the region of Salem (which included Dharmapuri until 1961), on the basis of populations classified according to quinquennial age[3]. Figure 4 provides a comparison between Salem and Dharmapuri with Tamil Nadu as a whole. It takes up the aggregate data, relating them to the average date of birth of the generation concerned. Thus, for the census of 1991, the SR of the 0-4 year age group is placed in 1988-89, that of the 5-9 year age group is in 1983-84, and so on. This juxtaposition of values enables one to date the assigned generations affected by the changes in the differential mortality and sex selective abortion. This graph makes it possible to distinguish the particular situation in Salem, where the decline in the proportion of girls has been extremely rapid and early. A polynomial smoothing of the data pertaining to Salem shows the

[3] We have confined ourselves to populations of less than fifteen years, for which the effect of migrations on the sex ratio is negligible. However, the inaccurate declarations of age can affect girls and boys in a differential manner.

Figure 4: Child sex ratio estimated using census age distribution, Salem, Dharmapuri and Tamil Nadu, 1950-2000



Note: Sex ratio of 0-5, 0-7, 5-10 and 10-15 age groups are plotted against their average year of birth. Polynomial trend lines added.
Source: computed from the Census of India, various years. Vella 2005.

historical trend of the SR, which departs from a historical level of 980 and begins to decline noticeably from the 1960s onward. The deterioration in sex ratio accelerated during the years 1970-1990 and during this period the SR declined even more, sinking below the value of 900 in 1991. However, the JSR may reach a plateau during the next ten years since the extent of the decrease seems to have somewhat slowed down. On the contrary, the decrease has been growing during the 1990s in several low-JSR areas of India (Premi 2001). The profile of Dharmapuri follows that of Salem, however with a lag of more than ten years. The decrease recorded during the 1990s is also slightly under that of the previous decade. In the rest of Tamil Nadu, the declining tendency of the infant SR is still later, and above all less prominent (Vella 2005).

Micro-spatial trends in Tamil Nadu

Spatial analysis appears to be more appropriate and pertinent for presenting the results, making possible a detailed study of the variations in the SR

within the state. The map of Figure 5 represents the geographic characteristics of the juvenile sex ratio in Tamil Nadu in 1991[4]. This is a new representation in the context of Indian research into questions of sex discrimination. The point of departure for the spatial modelling was a digitized map of South India. It represents all the villages of Tamil Nadu, which were available for the first time as computerized data with the help of the 1991 census (Guilmoto *et al*. 2002). The data, available in numerical form, were systematically subjected to a series of tests relating to both internal logic and external controls. The outliers and other erroneous data were thus detected and corrected, using the printed publications of the census when they were available. This leads to an improvement in the statistics, which in turn makes the SIFP database a source of very good quality. There are, however, villages for which the census estimates give rise to doubt, as well as some that could not be precisely located. As there is but one available source, and because some publications of the 1991 census were belated, the spatialization of data has been made more complex. It was at times necessary to use older maps and to combine all the available cartographic sources to identify and locate the census villages. Various tests have shown that local errors in localization do not exceed 500 metres, which on the scale of South India is negligible.

In view of the very large number of village units in South India, an aggregation of villages has been carried out calculating the spatial averages and grouping them in a radius of 10 kilometres using the Thiessen-Voronoï method (see annexe). This grouping limits both the number of statistical units to be treated and the number of villages with populations that are too low. In addition, units with less than 50 children were excluded. A spatial interpolation was carried out with the amalgamated data of the JSR by the ordinary kriging method, which is a standard geo-statistical technique of estimation (Chou 1997). Then, the contouring of the homogeneous statistical regions was carried out. The value of 900 was retained as the threshold of abnormality of the JSR to facilitate the clarity of the map.

The map makes it possible to disaggregate large regional units and to show with greater precision the micro-regional contours. It measures here the intensity of sexual discrimination in Tamil Nadu. This cartography of the JSR in 1991, (Figure 5) reveals the heterogeneity existing within the state. In most areas, the SR of 0-6 years is over 950. But the situation shows itself to be different in some apparently isolated pockets where the JSR is lower than

[4] Similar village-level data from the 2001 census may not be available for several years.

average values, for example west of Madurai and in the Salem-Dharmapuri pocket. One will again note the strong spatial compactness of the phenomenon, which does not result of the geo-statistical smoothing carried out on the basis of more detailed spatial data (Vella 2005). The proportion of girls is the lowest in the north-west, and the highest in the south-east of Tamil Nadu. Three taluks[5] have particularly aberrant values: Sankari, Mettur and Omalur (Salem district, map of Figure 7). The magnitude of the girl-boy imbalance is considerable when the values below 660 are observed in this area. These are regions where one out of three girls was lacking, in 1991. At a more micro-level in this zone, numerous villages with more than 2 000 inhabitants are to be counted where the JSR is two boys for each girl. We have here without doubt the absolute peak of discrimination against small girls in Tamil Nadu and even in India (Vella 2005).

But, apart from that, it is advisable to consider the temporal evolution since the census of 1991. The phenomenon has advanced and extended to new taluks, and some authors mentioned, in 1996, a "contiguous belt" to spatialize the female discrimination (Athreya and Chunkath 2000). This zoning of discrimination begins in the western half of the district of Madurai and extends across the districts of Salem and Dharmapuri as far as the western part of North Arcot district (Vellore). In fact, infanticide was first identified through the media in Madurai. Some believed the phenomenon began there and then spread in an unknown manner to other, adjacent districts [6]. However, Salem appears clearly as another specific core area of low juvenile sex ratios in Tamil Nadu. The districts in the south, the east and the delta of the Kaveri River seem unaffected by infanticide. No anomaly has been located in these zones, if not, in 1999, in some districts that are located somewhat outside the Madurai-Salem axis. Another exception concerns the two districts of Coimbatore and the Nilgiris, which, in the west on the border of the corridor, do not seem affected by discrimination, according to the presently available data (Vella 2005).

[5] A taluk is an administrative division of the district.

[6] The NGO Alternative for India Development challenged the revelations of the government on infanticide (AID, 1999). In the beginning of the 1990s, infanticide was confined to Madurai, according to the government, as no other data was published. The Community Service Guild Salem and AID Dharmapuri thus disclosed infanticide to the media in these zones, for they have worked for several years in these districts, but the results were not accepted by the government until 1992. Then, the latter initiated, in 1997, a programme of street theatre in Dharmapuri under the aegis of the Danish Agency for Development Association, DANIDA (Athreya and Chunkath 2000).

As discrimination seems to have spread regularly, it could have been useful to compose a map at the micro-scale of villages of the two districts of Salem and Dharmapuri and based on several years, but the JSR is only available in the census results for 1991. It was thus not possible to have a historical view of the phenomenon at the micro-scale. Nonetheless, the strong relation between the SR and the JSR in this case allows us to use the first to evaluate the second. It was then possible to illustrate the decline of the JSR by mapping the SR from 1961 to 1991 at the village scale, which enlightens the spatial diffusion of the discrimination. A comparison of the maps of sex ratio and child sex ratio in Tamil Nadu shows a strong correspondence between the two maps (Figure 6).

Spatial analysis of the evolution of sex ratios between 1961 and 1991 in Salem and Dharmapuri districts

On the basis of the census years of 1961, 1971, 1981 and 1991 (the 2001 data have not yet been published at the local level), it has been possible to rebuild the spatial diffusion of the phenomenon of sexual discrimination at a scale of the 1500 villages that constitute Salem district, today divided in the two districts of Salem and Dharmapuri. Globally on this map of sex ratios of Figure 7, which has been established in the same way as the other two, we can observe a clear growth of "discrimination" in thirty years, the blue areas advantageous to women disappearing while the red areas spread and intensify. In 1961, the sex ratio was mainly between 950 and 1000, which means that the sex ratios are not very unbalanced. In 1961, we also notice a strong North-South contrast, contrast that has been disappearing for four decades. Areas in favour of women are near Nammakal and above Salem (Figure 8: map of towns). One region seems a discriminatory place for women, or a place that men are leaving: the region of Denkanikota and Krishnagiri in Dharmapuri district. We find some pockets also near Mettur and above Harur. We can therefore try to understand what was happening in 1961 in Dharmapuri, because unbalanced sex ratios are spread in this district, whereas we saw in the case of the JSR results that the discrimination in this place was belated in comparison with Salem.

In 1971, there is an expansion of "discrimination" to the south-west and to the south-east, while the favourable areas disappear. There is a change in the tendency; Salem is now noticed for unbalanced sex ratios, whereas in Dharmapuri they are less. But in Dharmapuri, the high maternal mortality

could have explained the places of discrimination, as this district is late in development. After that, in 1981, it is in Salem that there is an accentuation of "discrimination". In 1981, we observe an extension of unbalanced sex ratios to the west, north and south, with an accentuation of discrimination. Observing the juncture of north and south on the west side of the districts, there are no more favourable areas. We find the same pattern in 1981 as on the map of Figure 5, the heart of discrimination near Idappadi and Omalur. In 1991, there is a large diffusion, with a meeting of discrimination places; discrimination is accentuated with increasingly lower sex ratios, less than 850. In 1991, there is a meeting of places in west and east. Of course, it is difficult to understand all the factors that might explain this diffusion; migratory mechanisms could be involved in the Dharmapuri villages, for we are near Bangalore and there are significant migrations from this district to Karnataka and Andhra Pradesh. But in Salem, this diffusion is no doubt linked to the diffusion of discriminatory practices such as infanticide or sex selective abortions. Areas advantageous to women are much less in 1991, except for one small area near Namakkal and a bigger one in Krishnagiri; this place could be a resistance pocket to "discrimination".

Discrimination and diffusion

These sections establish the existence of pronounced sexual discrimination, which is also dynamic in that it continues to progress and spread to new regions and to new social groups.

This evolution reveals the typical mechanisms of diffusion. It would be useful to understand at present how a social practice such as infanticide emerged, in a particular period of time and in a precise socio-spatial field, to then be propagated in a directional manner. This propagation seems, in fact, to take place in a specific manner in space and in Tamil society. We have clearly seen, on the basis of a new cartography, the spatial organization of the phenomenon. The notion of diffusion helps one to envisage, from a dynamic point of view, how this organization was put in place. The definition of diffusion is the phenomenon of propagation, in time and space, of a specific thing, such as an idea or a sociological or cultural practice, among individuals or groups (Rogers 1995). The schema is perfectly applicable to infanticide, the existence of which was probably very reduced and localized more than fifty years ago. It could therefore be a recent

practice, and the 1971 map of Figure 8 could give us a good idea of the beginning in the Salem area. The diffusion of a precise technique, such as ultrasound scan, connected with that of selective abortion, is also at the heart of our problematic (Vella 2005).

Once infanticide has appeared in a given region and in given communities, a potential diffusion exists that is all the greater the higher the group which adopts the practice stands in the social hierarchy and provides a reference for the rest of the local society. One therefore expects to observe a progressive spreading of new practices around a seat of original dissemination, and this is the overall image of the geography of sexual discrimination in Tamil Nadu, centred on Salem and Madurai and now Dharmapuri. The practice of infanticide and selective abortions seems to have been mainly promoted by the Kongu Vellalar Gounders (KVG), an agricultural caste. They would have historically adopted infanticide for different reasons, from change of economic status because of adoption of a new activity of transport in the years 1960-1970 to the adoption of dowry and a modification in their marriage pattern (from consanguineous to hypergamic marriages). Thus, by way of social propagation, on the basis of their dominant caste position, they would have transmitted the practice to other communities in a favourable socio-economic context, especially in Omalur and Edappady, where the literacy rate is very low compared with other places in Salem and where the rate of scheduled castes with low economic status is very high. We should point out that socio-economic conditions are not very good in Dharmapuri and Salem districts. These are dry districts, especially Dharmapuri; irrigation is very low there, agriculture is more widespread, industry is belated, the urbanization and literacy rates, especially for women, are also low in comparison with other districts. Moreover, Dharmapuri is the most recent district in Tamil Nadu: here the health results are also bad, maternal mortality and child mortality are the highest in Tamil Nadu and the rate of working children, especially girls, is very high. The Kongu Vellala Gounders would have played, therefore, the role of a "pioneer" group that propagates an "innovation", on the basis of factors of social, cultural and geographic proximity. Furthermore, the KVG settled in Dharmapuri district around 30 years ago after having bought land, and they could have brought the practice with them, propagating it to lower castes such as the Vanniars. In this caste of KVG, there was traditional family planning to avoid the division of landed property. We observe the

same phenomenon in North India, where landed people discriminated against their girls before the practice was adopted by the lower castes. The diffusion will be here in the first place vertical on the social scale (top-down model), from the elite to the whole of the local society.

The diffusion involved infanticide, but no doubt also other practices such as dowry and the renunciation of marriage by preference. Even though the effects vary according to social class, community and religion, spatial proximity facilitates the propagation. It then combines with mechanisms of horizontal diffusion, that is, across space, beyond highly homogeneous communities existing in the small region of origin. This diffusion occurs through the expedient of privileged channels which are socially structured: the exchange cannot take place other than through individuals and social groups which maintain contacts, and only has an effect in terms of the quality and volume of the latter. In addition, strictly geographical distance has a crucial bearing on the intensity of these exchanges. Interpersonal exchanges remain, in fact, the favoured support of the communication of information and the formation of systems of norms and representations.

The spatio-temporal evolution of the phenomenon remains also closely linked to the medical, penal and political evolution in Tamil Nadu. In effect, sex-selective abortion is today available throughout the state, owing to the multiplication of private clinics and ultrasound scan equipment. The reproductive practices of women have been subject to the strong impact of the transfer of technology they have encountered by going to hospitals, dispensaries and clinics for family planning, the monitoring of pregnancies, or for childbirth.

While the diffusion of infanticide and selective abortion seemed, in 1991, limited to a few zones, it is without doubt, as we saw, much more extensive today, extending beyond the historical region of its appearance. Detailed data from the census of 2001 will make it possible to confirm these hypotheses of diffusion. It remains that the declining tendencies of the juvenile sex ratio, indicated by the available statistics, and considering that the discrimination of girls in all forms has become stronger, foretell that the new century will be characterized by a singular deficit of women in certain parts of Tamil Nadu. Moreover, there is a clear transition from infanticide to selective abortion, but NGOs working in the field say that infanticide is not disappearing at all (being an additional effect more than a substitution). This

paper has clearly shown, through an examination of the social and spatial contours of the phenomenon, that the dynamics of sexual discrimination is a complex phenomenon that has its roots in the specificity of a regional cultural area, in the consequences of structural economic changes that mark rural India, and in the mechanisms of the diffusion of social change.

Annexe : How to process the data

Cartography is not a minor operation and, as it is a question of dealing with 70 000 units of South India, it is best to reflect upon the methods employed. The first thing one notices when observing the size of the database is the number of units that can be presented on one page. The representation of all the villages of Tamil Nadu alone in a simplified area form (like the polygons of Thiessen, for example) on an A4 (21cm x 29.7cm) page is already no longer possible. Among other solutions, we chose the use of a continuous range of values, rather than of points and polygons. This makes it possible to leave these representational problems by forming a continuous grid of pixels that eliminates direct references to villages.

The solution, which consists in aggregating the data according to a defined spatial procedure, corresponds to the creation of a new point situated at the centre of gravity of the concerned points, defined according to a spatial rule. For example, all the original villages less than 5 kilometres will be aggregated and their data combined to form a new statistical unit. The spatialization of phenomena will be given greater consideration if the data are aggregated under application of a spatial constraint than if a pre-defined grid is employed. Underlying this operation is the geographic rule that the objects closest to each other have the greatest resemblance; this is the principle of spatial autocorrelation.

Although this procedure is not always expedient, it has two reasons for being so in our case. On the one hand, the aggregation of data is legitimate; there is no risk of eliminating a strong heterogeneity of demographic characteristics. On the other hand, and this is an important point, the aggregation allows of the reduction of the statistical noise produced by the small units. It is, in fact, hazardous to use villages with populations that are too low to allow of a calculation of the indices.

The other solution tends to eliminate references to the administrative framework of the existing habitat. The grid obtained represents the variations of the studied phenomenon in a continuous manner in space; one moves, in fact, from a territorial approach to a spatial approach that is much richer in information. To this purpose, the map must be transformed into an orthogonal grid formed of elementary cells (pixels). The smaller the pixel, the finer will be the grid and the database will be correspondingly large. In each pixel, the corresponding value will be calculated by weighting the

values of the villages that are present within the pixel, or by interpolating the value of the surrounding villages. A spatial smoothing is thus carried out, eliminating the punctual representation of each value to give the regional tendencies of the phenomenon. The resulting map is much easier to read because it erases the micro-variations that would not be legible.

Our procedure combines these solutions. One first carries out a spatial aggregation, which significantly reduces the number of demographic units. The aggregation makes it possible to remove the majority of units the sizes of which are too low. Second, a spatial smoothing makes it possible to reconstitute regional tendencies.

The level of aggregation retained is 5 kilometres, as it allows us to compare all the southern states and satisfactorily increases the soundness of the variables. Fewer than one hundred clusters have then a population of less than 1 000 inhabitants. Another not insignificant advantage is that the number of units to be analysed is considerably decreased, becoming somewhat less than 7 000.

This reduction makes it possible to carry out the method of smoothing in a reasonable period of time, as the volume of calculations naturally corresponds to the number of geographic units considered. For the smoothing of data we shall use the kriging method. This method is based on a model of spatial autocorrelation and, as such, rests upon quite weighty calculations.

A contouring can be applied so as to bring certain zones to the fore. However, although the contouring appreciably improves the reading, it sets a trap for the reader: by doing away with the continuous aspect of the variation, it gives the impression of a division between each zone and of creating classes of values that may be arbitrary.

It is, therefore, necessary to keep in mind that the data obtained appear in a distinctive and continuous manner, whereas the choice of values for the contouring is arbitrary. In the same way, one cannot “look for one’s village” on the map. The variations expressed are local tendencies, based on averages, and sometimes conceal more complex local situations.

The aggregation was devised by C.Z. Guilmoto.

	Number of villages	Village size	Inhabitants	Men	Women	Sex Ratio	Distance between villages
1991	2047	2417	4948381	2556633	2391748	935	3,8 Km
1981	2040	2085	4253059	2174904	2078155	956	3,8 Km
1971	2001	1862	3726338	1893142	1833206	968	3,8 Km
1961	1462	2106	3078782	1554768	1524014	980	4,4 Km

Of the 2 200 villages of the database : 677 villages (1/3) did not exist in 1961, 170 villages (8%) existing in 1961 were grouped, 1 353 (61.5%) underwent no geographical change.

The cluster size depends on the middle distance between villages (from 4,4 km in 1961 to 3,8 km in 1991). 529 clusters remain. Villages with less than 200 inhabitants in 1991 have been suppressed.

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Figure 1: Map of India

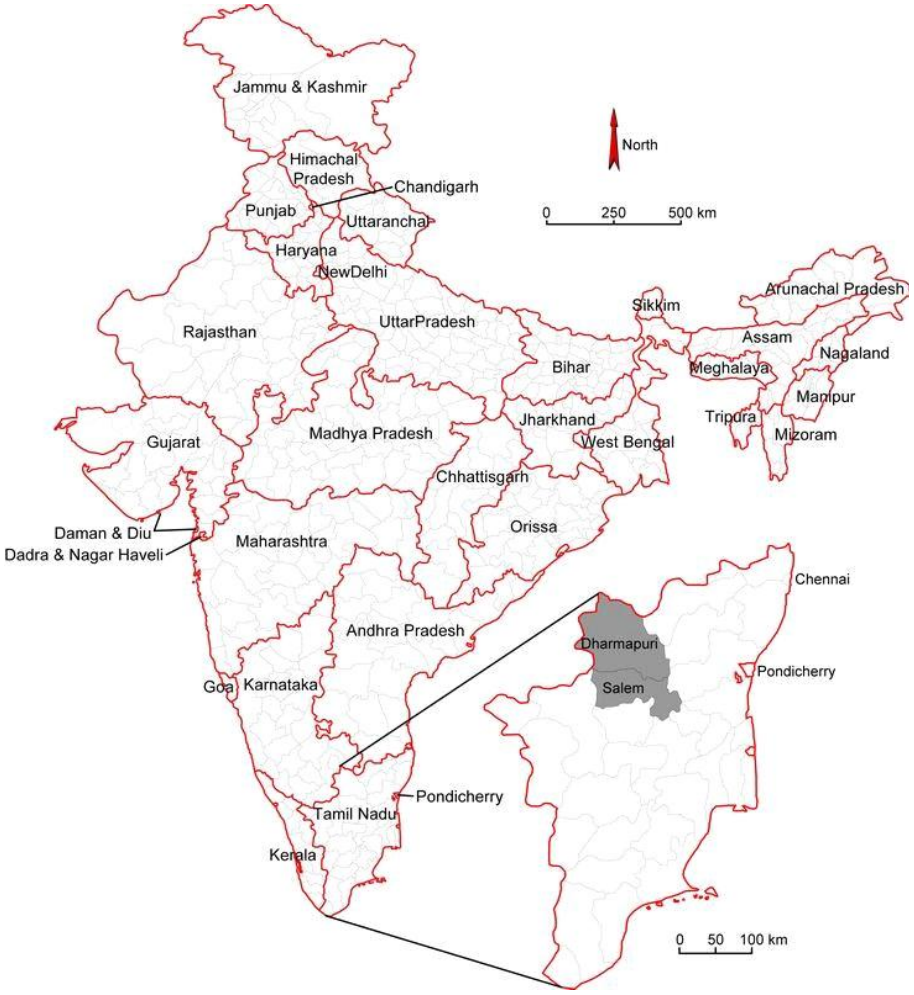

Figure 5: JSR in 1991

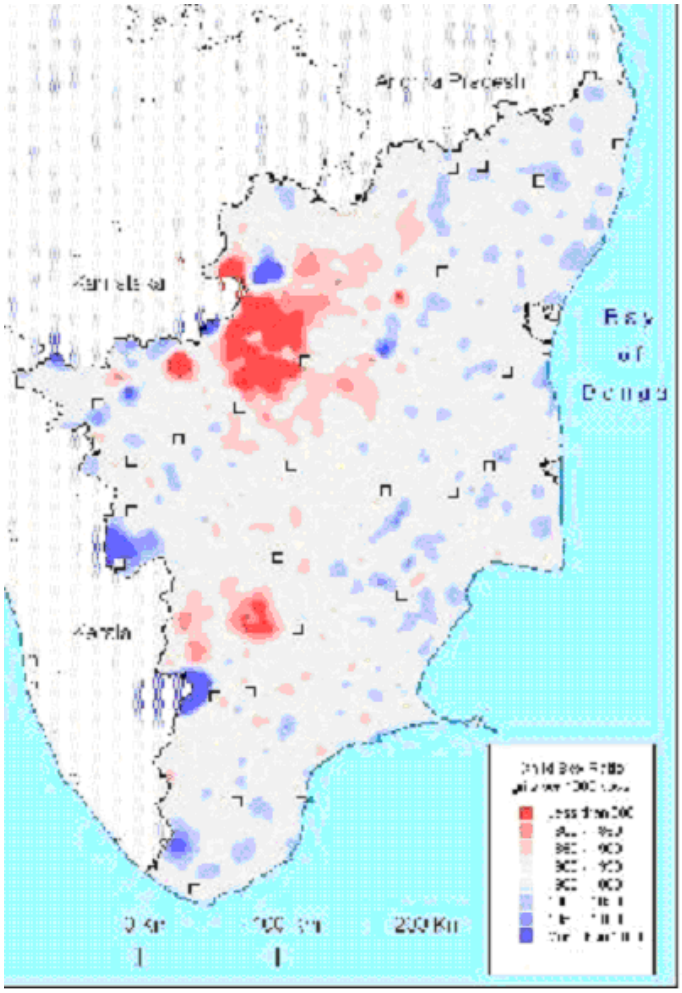

Figure 6: Map of Juvenile Sex Ratios and Sex Ratios in Tamil Nadu, 1991
C: SIFP, Sebastien Oliveau

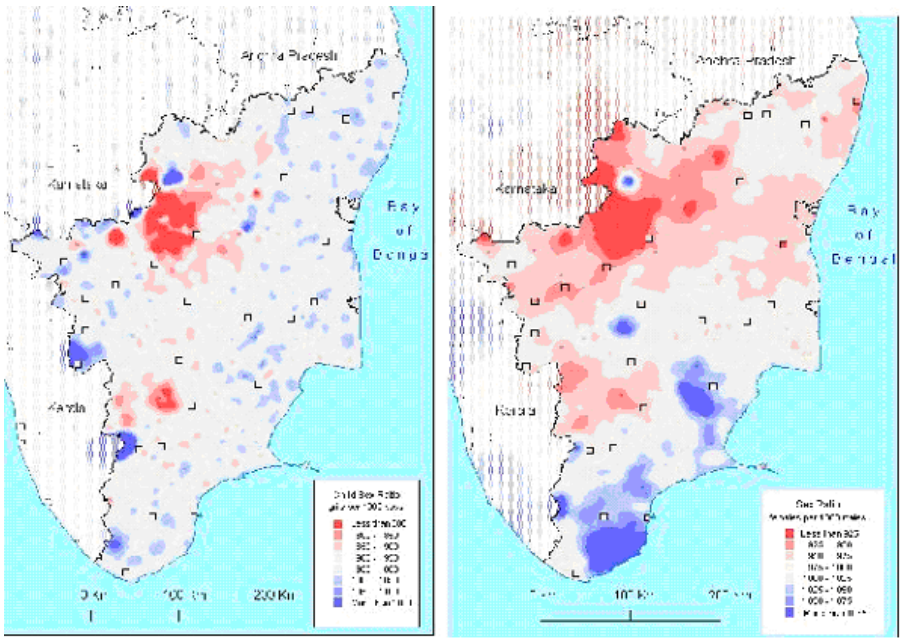

Figure 7: Maps of sex ratio in Salem and Dharmapuri districts, Tamil Nadu, 1961-1991

C: SIFP, Sebastien Oliveau

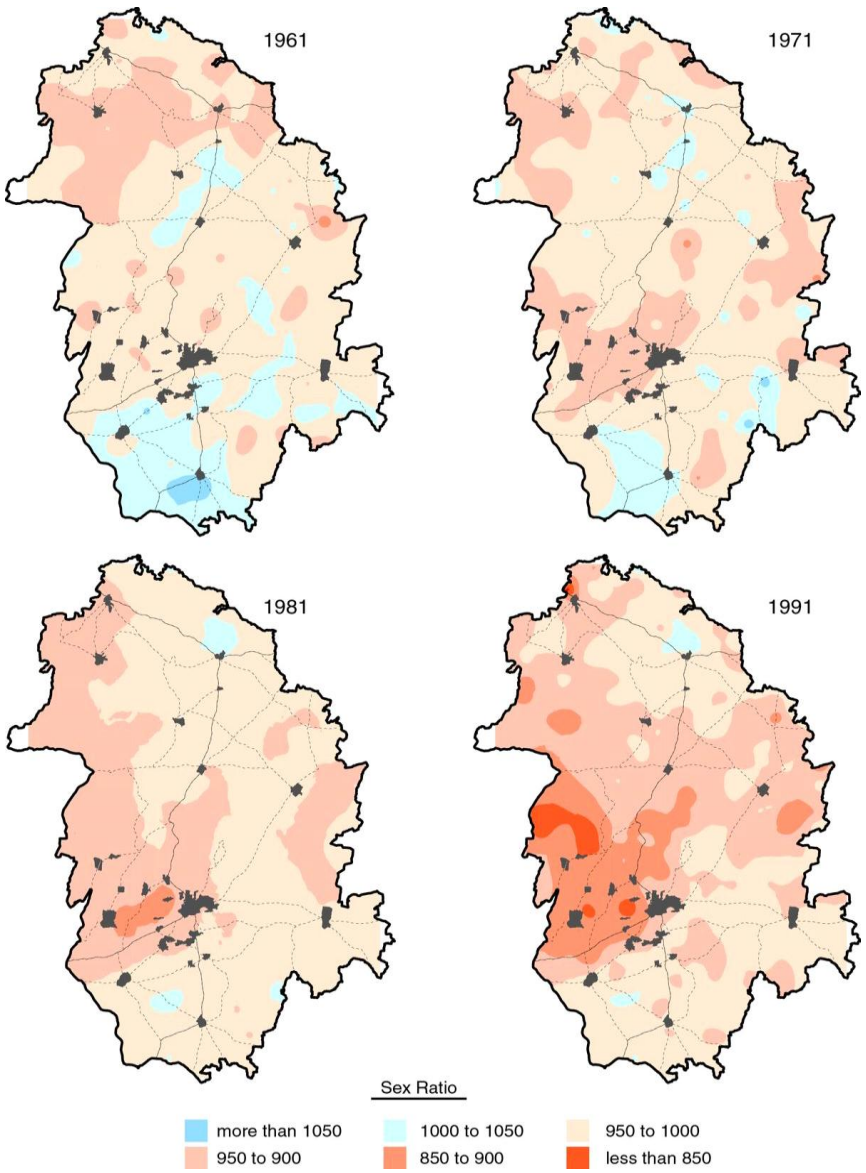

Figure 8: Map of towns in Salem and Dharmapuri districts
C: SIFP, Sebastien Oliveau